

DESCRIPTIONSYSTEM TO FORM A LAYERING OF ELECTRONICALLY-
INTERACTIVE MATERIAL

The object of this patent is a system for the formation of a
5 layering of electronically-interactive material, according to the
characteristics of main claim.

Technical Field

By the term electronically-interactive material, we mean
any kind of material which is capable of electronically interacting
10 both in an active sense, such as through conductivity, or in a
negative sense, such as through insulation, and does not exclude
other parameters such as the typical on/off function which
characterises micro-processors.

The invention may be used preferably, but not exclusively,
15 for the formation of a layering of electronically-interactive
material, such as in: the manufacture of electronic circuit boards;
the creation of screens with a layer of electronically-interactive
material to project images from a flat screen to create displays,
which may also be flexible, directly incorporating a computerised
20 system which does not exclude the function of a microprocessor
with both organic and non-organic material, including the
function of intelligence which may or may not be artificial,
similar to cerebral functions, and also visualisation or non-
visualisation with different grades of variable luminosity materials
25 by means of electronically induced phenomena which cover the
entire range of the spectrum.

Background Art

According to the current state of the technology, the

formation of a layering, either composed of a single layer or a number of layers, is carried out by either mechanical, chemical or photo-chemical methods. The techniques of layering with mechanical systems are slow and not very suitable for the miniaturisation and precision which modern electronic techniques need to acquire.

For example, in order to create electronic circuit boards, which is one of the main, although not exclusive, uses of this invention, either photographic or photo-engraving techniques are used, and which are far superior to mechanical systems.

In spite of this, modern technology requires techniques which are more rapid and efficient, and which also have miniaturisation and precision capacities superior to those achieved up until now, if possible.

It is well known that, even with photo-engraving techniques, since a photo-sensitive layer has to be engraved, it is not possible to create designs and miniaturised circuits below a certain dimension. That is, it is not possible to go below certain values, which are determined by the minimum distance between two engravings, otherwise it would make the thin layer between them unstable because, if it is too thin, it could be easily detached or ruined. As a general rule, an acceptable value for the ratio of the distance between one engraving and another and the thickness of the layer >1 . In fact, if the said ratio were less than 1, the height of the section of the layer would be greater than the width, so the risk of breakage and a resulting short circuit between two adjacent circuits would be high.

Aim of the invention

The aim of this invention is to overcome the aforementioned drawbacks and to allow a layer of electronically-interactive material to be rapidly and quickly formed on a surface, which has the maximum precision even with the smallest of designs and
5 which has an extremely low cost.

Explanation of the invention

The problem is overcome according to the characteristics described in the main claim.

Advantages

- 10 The advantages obtained with this solution are the following:
- Speed of the process.
 - Maximum simplicity.
 - Maximum precision.
 - Maximum miniaturisation of the structures designed and
15 integrated in the layer.
 - Maximum reliability, safety, robustness and duration of the layering.
 - Overall reduction of manufacturing costs.
 - Respect for the environment with the elimination of all waste
20 materials or pollutants.

Detailed description of an application

These and other advantages will be shown in the following description and attached drawings of a preferential application of the solution, the details of which are intended to be an example and
25 not a limitation.

Figure 1 is a schematic view of the mechanical solution of the application machine for the formation of a layering of electronically-interactive material on a support sub-layer, such as

in the manufacturing of an electronic circuit board.

Figure 2 is a three-dimensional schematic view of the feeding system of the distribution unit for the material used for the formation of the said layering of electronically-interactive material.

Figure 3 is a view of the distribution unit for the material used for the formation of the said layering of electronically-interactive material.

Figure 4 is a schematic front view of the various components of the distribution unit of the system according to the attached claims.

Figure 5 is a three-dimensional schematic view of a machine which embodies the system for the formation of a layering of electronically-interactive material, according to this invention.

Detailed description of the solution illustrated in the drawings

With reference to Figure 1, it is clear from the characteristics in the claims that the formation of the layer of electronically-interactive material is carried out according to an innovative technique compared with previous technology, as follows:

- A support (a board of plastic material S, for example) is positioned on a mobile bed 2, where the movement of the mobile bed 2 is controlled and programmed by a microprocessor according to a given co-ordinate (Y).
- Above, there is a distribution unit for punctiform jets of the liquefied material to be deposited (3) in order to form the said layer on the said support (S). The distribution unit is programmed to move transversally in a controlled manner by a

- microprocessor, similar to that of a traditional inkjet printer, with the said distributor having a number of nozzles for the distribution of points the equivalent of pixels, which are able to cover a certain area equal to $n \times d$, where "n" is the number of
5 nozzles which are sprayed in line, and "d" is the distance along the line from one nozzle to another, with a layout, for example, along three lines alternately disposed, 1, 2, 3, for a length of 70mm.

- The forward progress of the underlying support is in steps of
10 70mm, up to the complete deposit on the surface of the support in question (S).

Figure 2 illustrates the feeding system of the liquefied material (which may be coloured, for example, with conductive powder in suspension in the various containers with a respective electro-
15 induced vibration mixer), which basically comes from a main container 4 with a cover for loading 40.

This container has two tubes for the liquefied material: one is the feed line 41 by means of a solenoid check valve 410 to a pressure equaliser and regulator 5 which will be described in
20 detail in the successive function, and a return line 71 from a recovery and recycling container of the same liquefied material 7, the function of which will be described later.

In this description, the liquefied material means the said material used for the formation of the said layering of
25 electronically-interactive material used to cover the said support or plate of plastic material "S".

From the bottom of the said pressure equaliser and regulator 5, there is a pipe 53 which leads to the bottom of a buffer 6 with an

upper air chamber "A". The liquid to be deposited settles in the lower part "L", where there are pipes which take it the nozzle chamber 31 which forms the said distributor. The said buffer 6 is suitable, therefore, to contain the said liquefied electronically-
5 interactive material "L", while the upper air chamber "A" acts as a pressure compensator, that is as a damper, being able to increase or reduce according to the emission and/or consumption of the liquefied material and, therefore, increase or reduce the request for material from the intermediate pressure equaliser and
10 regulator container (5).

The said buffer 6 is positioned above and is joined to the distribution means 31. Also, the said pressure equaliser and regulator 5 may move upwards and downwards parallel to the up and down movement of the said distribution means 31 and the said
15 buffer 6 on guide carriages 52, and may also be finely regulated in height with respect to the height of the said buffer (6) and the said distribution means (31) so that it may regulate the pressure either higher or lower for the difference in level according to the principle of communicating vessels, with the pressure variation
20 induced by impeding the principle of communicating vessels by means of the presence of the said air chamber "A" in the said buffer 6. In this way, by being able to regulate the pressure either higher or lower according to the programmed value by means of the computer control with a micro-processor, the highest
25 functionality is achieved.

It thus becomes possible to comply to the following conditions according to the program:

- i. start distribution at the start of the transversal movement according to "X" with a distribution pressure p_1 ;

- ii. vary the said pressure immediately afterwards to the value p_2 , where $p_2 < p_1$, with repetition of the cycle for every transversal movement of distribution-deposit "X";
- iii. vary the distribution again to a value of p_3 , so that $p_3 > p_1$, for
5 a cleaning operation of the filters where the said material passes, to carry out a maintenance cycle during a non-operational phase, that is, material not being deposited according to "i" or "ii".

According to Figure 4 which schematically illustrates the
10 distribution unit 3, we can see that, at the side of the said distribution means 31, on one side there is an ultra-violet light transmitter 34 which has the function of polymerising the fluid distributed on the surface of the support material (S), with the
15 the action of ultra-violet rays, and on the opposite side there is an ultra-sonic distance sensor 32 which detects the distance of the underlying support (S) from the depositing bed and transmits the respective data to the processor so that, according to the program, it brings it closer, takes it further away or holds it at the same
20 distance.

There is also a television camera 33 to the side, to view the surface of the support zone subject to the deposit in question, both for the fine tuning by means of reference points according to a well known technique, and for checking the correct distribution,
25 depositing, regularity of the covering, etc.

According to Figure 5, we can see a three-dimensional schematic view of a machine which includes all of this equipment in order to use the system according to the characteristics in the

claims. The machine has a base 1 which includes the electric and computerised electronic system, with a control computer therefore, and which also has the function of supporting the mobile bed 2 which is moved longitudinally by means of worm screws 20, the
5 rotation of which is controlled by the said computer. The support panel "S", such as an electronic circuit board (in plastic material, for example), on which the layer of electronically-interactive material is to be formed, is placed on the said bed.

A further transversal worm screw 30, the rotation of which
10 is controlled by the said computer, is positioned above the said mobile bed (2). This transversal screw 30 carries the said distribution unit as described 3.

The system for feeding the liquefied material is connected laterally to the said distribution unit (3).

15 The feeding system is carried out, as already stated, in a controlled way by means of the said three containers 4, 5 and 6 with their respective piping.

At the back, block 340 forms the ultra-violet ray generator which feeds the said ultra-violet ray transmitter 34.

20 Going back to the said main feed chamber 4 and cover 40, it must be made clear that it also has the return pipe 71 which comes from a lateral tank 7 fixed at the side of the mobile bed 2, in order to be covered during the washing phase of the said distribution unit 31 during the non-operational phase of washing the filter
25 with a higher pressure p2.

In this case, the fluid which is fed for the washing phase, which is neither polluted or damaged, is recovered by the said tank from below the nozzles in the said distributor means (31), and

taken by means of the said pipe 71 to the said main container 4.

All three of the containers 4, 5 and 6 have a vibration unit inside to keep the liquid constantly in motion during the feeding operation, in order to keep the suspended substance, which is heavier than the liquid, uniformly distributed (eg. copper powder for the conductivity of the material, pigments for the insulating material, etc.)

The ultra-violet (UV) ray device 34 advantageously works at room temperature and, because it heats up, it is cooled down at the same time according to a controlled temperature by suitable equipment which is part of the machine. In this way, the polymerisation of the deposited material is carried out at room temperature without damaging the material or the support, and without compromising the functionality of the entire depositing unit (3).

The distribution nozzles for the material to be polymerised by means of the distribution unit 31 are advantageously conformed to supply punctiform (pixel-by-pixel) sprays equal to 1 pixel at time in logical succession.

There are one or more rows of distribution nozzles. More rows of nozzles or distributors may be foreseen in order to deposit different materials.

An example of different materials could be the following, for example:

- conductive material;
- insulating material;
- covering or protective material.

A further advantage is that the system includes the

activation or shut-down of the said ultra-violet ray polymerisation device (34) in a controlled way to make the following possible:

- the direct polymerisation immediately after being deposited, or
- to fix it.

CLAIMS

1. A system for the formation of a layering of electronically-interactive liquefied material, which may be solidified/polymerised, on a support surface formed by a sheet or card or on a support panel (S), characterised by the fact that:

- a computer controlled machine is used, with a mobile support bed which goes backwards and forwards (2, 20, Y) with a transversal bridge passing over it and which has transversal guide means for the alternate transversal movement above the said bed of a distribution unit for the material (3), in which there is a distribution means for point-type sprays (31) at programmed differential pressure, equipped with a series of punctiform nozzles to distribute respective points of the liquefied material, which basically correspond to pixels, in a controlled, programmed way;

- the said sheet or card-type support or support panel (S) is fastened on the surface of the said mobile bed (2), and

(i) the said mobile support bed (2), on which there is the said sheet or card-type support or support panel (S), is moved forward (Y) according to the program below the said bridge and below the said distribution unit (3);

(ii) the said distribution unit (3) is moved transversally above the said sheet or card (S), and the said distribution means deposits, by means of points (31), and according to a programmed design, at least one layer of the said electronically-interactive material, with differentiation of the distribution pressure of the said liquefied material at two different values p_1 and p_2 , where:

"p1" is the pressure at the start of the distribution and depositing phase, and

"p2" is the continuous pressure during the distribution of the deposit, where it is essential that

5 $p1 > p2$;

- phases (i) and (ii) are repeated until the whole of the required surface interested area of the said support sheet or card (S) is covered.

10 2. A system for the formation of a layering of electronically-interactive liquefied material, which may be solidified/polymerised, on a support surface formed by a sheet or card or on a support panel (S) according to the previous claim, characterised by the fact that, during the non-operational phase, it is possible to apply a supply pressure "p3" > "p1" in order to clean a
15 respective filtering system in the feeding system of the said liquefied distribution-depositing material.

20 3. A system for the formation of a layering of electronically-interactive liquefied material, which may be solidified/polymerised, on a support surface formed by a sheet or card or on a support panel (S) according to the previous claims, characterised by the fact that, to the side of the said distribution means (31), there is an ultra-violet ray head which is suitable for polymerising the said electronically-interactive liquefied distribution-depositing material.

25 4. A system according to the previous claim, characterised by the fact that the said ultra-violet polymerisation head is electronically controlled to supply the energy required to fix the said material on the said support (S).

5. A system for the formation of a layering of electronically-interactive liquefied material, which may be solidified/polymerised, on a support surface formed by a sheet or card or on a support panel (S) according to the previous claims, 5 characterised by the fact that, to the side of the said distribution unit (31), there is an ultrasonic distance sensor (32) which detects the distance of the said distribution means (3) from the depositing surface on the respective support (S), and which transmits the respective data to the computerised means which controls the 10 movement of the said distribution means (3).

6. A system for the formation of a layering of electronically-interactive liquefied material, which may be solidified/polymerised, on a support surface formed by a sheet or card or on a support panel (S) according to the previous claims, 15 characterised by the fact that, to the side of the said distribution unit (31), a television camera (33) is installed, which has the function of controlling and fine tuning the start, and checking the regularity and conclusion of the distribution-depositing operation.

7. Computer controlled machine for the depositing of a liquefied 20 electronically-interactive material on a sheet or card or on a support panel, for implementing the system according to the previous claims, characterised by the fact that it includes:

- a base (1) to support the mobile bed (2) which is moved longitudinally (Y) by means of a worm screw (20) whose 25 movement is controlled by a computer, and for the support and fixing of the said support sheet/card/panel "S" on which the layer of electronically-interactive material is to be formed;
- a bridge above the said base with a transversal shaft (30) which also has a worm screw, to move a distribution unit for the

electronically-interactive material to be deposited (3) in an orthogonal direction (X) controlled by the said computer;

- the said distribution unit (3), with a pressurised distribution means with a series of nozzles for pixel punctiform sprays, fed by a buffer container (6) and above with the fed liquid material in the lower part "L" and air chamber "A", while to the side there is a pressure balance and regulation chamber (5) with its feed line (51) on the bottom (L) of the said buffer, and supply of the said liquid material from a feeder container-tank (4), where all of these containers (4, 5 and 6) have an agitation means and in which, the said pressure balance and regulation chamber (5) has a level indicator (51) and is guided parallel to the said distribution means (31) when rising and lowering, and in which there are means for varying and regulating the height of the said pressure balance and regulation container (51) to increase or reduce the pressure on the said buffer container either positively or negatively due to the difference in the level in a regulated way.

8. A machine according to the previous claims, characterised by the fact that the said feed container -tank (4) includes a connection to a tank (7) located at the side and which may be covered by the said distribution means (31), so that the said liquid material may be recovered and recycled at a recycle pressure of "p3", which is higher than the said distribution-depositing pressures "p1" and "p2", to carry out a cleaning cycle of the respective filtering means located upstream of the nozzles in the said distribution means.

9. A machine according to claims 7 and/or 8, characterised by the

fact that the said punctiform spray nozzles are positioned in a longitudinal direction (Y) with respect to the direction of movement of the said bed (2) in at least one row.

10 5 10. A machine according to claims 7 to 9, characterised by the fact that the said punctiform spray nozzles are positioned in a longitudinal direction (Y) with respect to the direction of movement of the said bed (2) in a number of rows.

11. A machine according to any of the previous claims, characterised by the fact that, to the side of the said distribution
10 means, there are:

- cooled means for transmitting ultra-violet rays for polymerising the said material which is deposited (34);
- means for controlling the distance from the surface to be deposited (32) and
- 15 - a television camera (33),

which are all connected interactively to send their respective data to the machine's microprocessor in order to carry out the respective control operations according to the program.

12. A machine according to any of the previous claims,
20 characterised by the fact that it has more than one distribution device (3) in the distribution unit for materials with differentiated electronically-interactive characteristics, among which at least one is actively electronically-interactive and one is non-actively electronically-interactive, or an insulator.

INTERNATIONAL SEARCH REPORT

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 A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 H05K3/10 B05C5/02 B41J2/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

 Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 H05K B05C B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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Information on patent family members

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